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IN RE THE APPLICATION OF	)	
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FOR: ORTHOPEDIC ARM AND SHOULDER BRACE	)	

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CLAIM FOR PRIORITY

Honorable Commissioner for Patents
United States Patent and Trademark Office
Washington DC 20231

Dear Sir:

Under the International Convention, for the purposes of priority, applicant claims the benefit of European Patent Application No. 02447173.2, filed September 12, 2002.

A certified copy of said application is appended hereto.

DATE: December 18, 2003

Respectfully submitted,

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Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

02447173.2

Der Präsident des Europäischen Patentamts:
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Anmeldung Nr:
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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Orthopedic arm and shoulder brace

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ORTHOPEDIC ARM AND SHOULDER BRACE

FIELD OF THE INVENTION

The present invention relates to an orthopedic portable arm and shoulder brace providing continuous passive motion of a users' shoulder.

BACKGROUND OF THE INVENTION

The shoulder is a relatively complex body joint having several ranges of angular motion, i.e., abduction, flexion and rotation. Treatment of a shoulder following an injury or surgical trauma typically requires immobilization of the shoulder, and the arm connected to it, for an extended period of time.

Splint-type devices have been reported for immobilizing and supporting an injured shoulder during the healing process. US 4,896,660 describes an arm support device comprising an upper arm support, a contoured well shoulder anchor, and a lower arm support. The upper arm support is operable to abut against a patient's side and underlies the humeral portion of a patient's arm. The contoured well shoulder anchor includes a contoured sleeve portion and two straps, which releasably connect the well shoulder anchor to the upper arm support. The lower arm support connects to the upper arm support structure and provides support for a patient's forearm and hand. FR 2,727,007 describes an inflatable cushion structure provided with different positioning means, which is applied between a patients' chest and its upper arm. FR 2,589722 and US 5,423,333 describe a device for immobilizing a human should r, and for supporting the wrist of the arm associated with that shoulder, comprising three inflatable bladders joined together to form a triangular wedge. The wedge is positioned underneath the patient's arm such that one bladder is positioned along the patient's side, and such that the patient's arm rests on another of the bladders. The device is designed in such as way that the patients' arm is maintained in a fixed angle in relation to the thorax of the patient. The angle between the arm and the thorax support is variable, depending on the possibility to fold one of the bladders of the triangular wedge. US 5,236,411 relates to a device for immobilizing the limb of a patient in an elevated position comprising an inflatable member that is adjustable between a deflated state and an inflated state and a harness for attaching the device to the body of a patient. The member is placed between a support surface and the limb of the patient, thus elevating the limb.

Nevertheless, although the above-described devices are suitable for immobilizing a shoulder, they immobilizes the shoulder in essentially one position against the body: the arm is immobilized in a particular angle in relation to the thorax, and no further movement of the arm is allowed. Also, these devices do not enable the embraced arm and shoulder to undergo combined movements, which are useful for effective reinforcement of arm and shoulder muscles after injury or chirurgical operations.

In fact, it has been found that effective rehabilitation requires the recovery of the ranges of angular arm and shoulder motion. A certain degree of mobility of the patients' limbs is required in order not to detract from rehabilitation of the shoulder. In view of this requirement, devices were developed which enable continuous passive motion of the patients' arm and shoulder from which EP 597,623 and EP 525,930 may be cited as examples.

EP 597,623 relates to an adjustable shoulder brace mountable on the arm and torso to isolate the shoulder which is fully adjustable across the abduction, flexion and rotation ranges of motion of the shoulder so that it enables fixation of the shoulder in virtually any rehabilitative position. The brace is made up of a series of rigid support members secured to the body of the patient, and a plurality of selectively rotatable and lockable joints adjustably interconnecting the support members. The combined effect of the joints simulates the entire range of motion of the shoulder. However, due to the presence of a plurality of joints for positioning the shoulder at selected angles of abduction, flexion and rotation, the device is very complex, uncomfortable and difficult to adjust. Also, this device immobilizes the patients' shoulder in a selected angle.

EP 525,930 relates to a passive shoulder exerciser constructed to move a patient's arm back and forth through an arc of up to 180 degrees for providing flexion and abduction of the shoulder. The shoulder exerciser includes a base, an electric drive motor, and an arm holder for the patient's arm, mounted to the drive motor for reciprocal movement by the drive motor through an arc of up to 180 degrees. The arm holder is slidably and pivotably mounted such that during use of the exerciser a patient's arm may slide towards and away from the body and pivot along two pivot points to allow the shoulder joint to follow a natural anatomical range of motion. However, this type of device does not essential movements, including combined movements of wrist and elbow. Furthermore, this device is cumbersome and

unpractical. As it is not a portable device, the patient needs to take place at this exercise and rehabilitation device every time he wishes to use it.

Another shoulder device meant to impart continuous passive motion to a patients' shoulder is described in US 4,651,719. A portable arm and shoulder brace causes abduction and adduction and has the option of causing simultaneous rotation as well through use of a single actuator. An upper arm support is pivotally connected to and extends laterally from the base of the device. A linear actuator extends between and is linked to the upper arm support and the base to cause abduction and adduction of the arm. A forearm support, which is pivotally connected to the upper arm support and angularly adjustable relative to the upper arm support, is linked to the base to cause rotation of the forearm support as the upper arm support is pivoted. The device is contained in a housing having a chamber with an extendable, two-part cover so that the operating mechanism is concealed. However, although portable, this device is rather large and particularly uncomfortable.

Considering the above-mentioned devices, the presently known devices show several drawbacks. There remains a need for a compact and comfortable orthopedic brace that enables all kind of single as well as combined passive movements of the embraced limb. Therefore, it is a general object of the invention to provide a brace providing continuous passive motion and overcoming the drawbacks of the presently known devices.

It is an object of the invention to provide an autonomous device suitable for embracing a limb, which is able to perform a number of different passive limb movements in an automated and controlled way.

It is a also an object of the present invention to provide a device suitable for embracing a limb, which enables single as well as combined movements of the limb.

Another object of the invention consists of providing a limb brace, which is a compact, easy to use and comfortable when mounted on a patient, even for extended periods of time.

It is another object of the present invention to provide a brace that increases the patient's ability to move around.

It is yet still a further object of the invention to provide a brace, which will effect any combination of the foregoing objects.

The invention is particularly suitable in the field of paramedical and orthopedic applications. In particular the invention can be used for the rehabilitation of all kind of injuries, especially of shoulder injuries.

SUMMARY

A preferred embodiment of the invention, which is intended to accomplish at least some of the foregoing objects, relates to a portable device suitable for providing continuous passive motion of a limb comprising:

- a brace for supporting said limb;
- a programmable motor providing continuous passive motion of said limb, said motor being mechanically connected to said brace; and
- flexible positioning means provided with a fastening means positioning said brace and said programmable motor on the body of a person carrying said device in a stable position;

characterized in that said programmable motor is at least partially housed within said positioning means.

The invention relates to a portable device to be carried on the body of a person comprising a brace for supporting an injured limb, a motor programmable to induce passive motion of the embraced limb and positioning means, to position the device on the body of the person.

The present invention provides a device able to provide different motor-driven passive movements of a limb. The presence of a programmable motor mechanism in the device allows an embraced limb to undergo passive movements in an automated and controlled way. The programmable motor mechanism comprises several units, which induce vertical or sliding movements. Due to its ability to induce several types of movements, the device according to the invention is particularly suitable for providing single, as well as combined movements of the limb. Surprisingly, although the limb of a patient is effectively supported and immobilized in the device according to the invention, the limb still can undergo single as well as combined passive movements, said movements being recommended for effective rehabilitation of the injured limb.

Importantly, the device according to the invention is highly comfortable, as the devic is portable, light and easy to apply. Moreover, the device is highly adaptable according to the anatomy of a patient carrying the device and is provided with a comfortable, flexible

positioning means for applying the device on a patients' body. Also, because the motor unit of the device is at l ast partially provided in the positioning means, the device remains compact and comfortabl from a patients' point of view. Surprisingly, bringing the motor mechanism of the device in the positioning means does not hinder the functionality neither from the motor mechanism, nor from the positioning means. Providing the motor mechanism of the device in the positioning means, at least partially, still enables the device to induce a series of different motor-driven passive limb movements. Also, although the positioning means is provided with at least a part of the motor mechanism, it still effectively positions the device on the body of a person carrying said device. In addition, as the device according to the invention it is portable; the movement facilities of a patient carrying the device are not restricted.

Other objects and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings.

DETAILED DESCRIPTION OF THE FIGURES

Figure 1 represents a upper view of the basic geometry of the lower and upper arm on a human body indicating the two points of control of movement, i.e. a point of control at the wrist 1 and a point of control at the elbow 2.

Figure 2 illustrates the arm and shoulder brace according to the device comprising a lower arm support 3, an upper arm support 4, a motor mechanism and positioning means 7 with a fastening belt 22.

Figure 3 represents a detailed view on the lower arm support 3 with arm fasteners 10.

Figure 4 is an exploded view of the motor mechanism comprising a hinge-like mechanical interface 14 comprising a sliding motor unit provided in a housing. The mechanical interface is connected with a secondary frame 15 and with the motor units 8, 9 that are at least partially incorporated in a bellows structure 6. This hinge-like mechanical interface is linked to one of the motor units.

Figure 5 illustrates the motor-driven translation movements, as indicated with arrow 17; and the not motor-driven endo / exo rotational movements, as represented with arrow 18.

Figure 6 depicts the device according to the invention provided with a remote control unit 19 and two connectors at the upper side of the air chamber, one for a transformer or batteries 20 and another for a remote control 21.

DETAILED DESCRIPTION OF THE INVENTION

It is often necessary for orthopedic specialists to secure the limbs against movement following injury or treatment of the limbs. Moreover, procedures involving surgery of the limb necessitate post-surgical immobilization, which facilitates recovery and helps to prevent further injury during the recovery period. However, in addition, the injured limb also needs to undergo some movements, in order to reinforce its muscles and in order to facilitate its rehabilitation. The present invention provides a device that complies with both requirements.

In a first embodiment, the present invention relates to a portable device suitable for providing continuous passive motion of a limb comprising:

- a brace for supporting said limb;
- a programmable motor providing continuous passive motion of said limb, said motor being mechanically connected to said brace; and
- flexible positioning means provided with a fastening means positioning said brace and said programmable motor on the body of a person carrying said device in a stable position;

characterized in that said programmable motor is at least partially housed within said positioning means.

The invention relates to a device, which facilitates the recovery and rehabilitation of limbs after injury, surgical operations or other problems. In particular, the device can be used to impose a continuous passive motion, "CPM", to a limb. CMP is defined as a continuous mechanical stimulation of the movement of a joint, in consideration of a patients' tolerable motion. The term "passive" refers to the absence of active participation to the movement by the patient.

Continuous passive motion therapy has been found to have beneficial results in the rehabilitation of injured limbs. CMP improves the healing of tendons and ligaments, enhances the metabolism of a joint, improves resorption of effusions and may prevent and even overcome joint stiffness as well as secondary arthrosis, muscle atrophy and soft tissue contracture. CMP provides a patient with anatomically correct motion that essentially

duplicates the normal rhythm of the affected joint. Passive motion is also used for treatment of other bone and muscular disorders, such as arthritis and muscular dystrophy.

In the following description, the device according to the invention will be described with regard to its application for providing CPM to an injured shoulder and an arm connected thereto. A continuous mechanical stimulation of the movement of a joint, in this case an elbow and shoulder joint in consideration of a patients' tolerable motion, is obtained. However, as it should be understand from the invention, the application of the device according to the invention is not limited thereto.

The device enables the embraced arm and shoulder, although immobilized, to perform a number of different kinds of automated passive arm movements. This device provides a particularly effective rehabilitation of shoulder and arm injuries. It shortens the rehabilitation time in general and shortens the hospital and the time of treatment, which is an important economic factor. The present invention provides a device which enables to shorten the period of treatment of an injured shoulder, preventing joint stiffness and maintaining effective joint movement.

The device according to the invention fits against the lateral portion of the torso under the shoulder of a patient carrying the device and provides support for the upper arm and the lower arm or forearm. Importantly, the device enables the embraced arm and shoulder to undergo a maximal possibility of movements of arm and shoulder over a broad range of angles and planes. As well be understood, the angles and linear displacements of the arm and shoulder will depend on the ergonomic limitations of all patients individually.

The basic geometry for upper and lower arm is represented on figure 1. As a starting point for the mechanical arm support system and the movement concept in general, the elbow position comprises an angle between the lower arm and the upper arm of 90° or less. The position of the lower arm is comprised within a horizontal plane, further referred to as the "neutral horizontal plane". The neutral position of the arm, viewed from above as represented on figure 1, consists of a position of the upper arm of 40° in relation to the shoulder line and a position of the elbow in an angle of 90° in relation to the shoulder. The points of control on the lower arm include a point of control of the wrist 1 and a point of control of the elbow 2.

The device according to the invention enables different types of movement to be performed by arm and shoulder. All movements can be converted to linear displacements. The motor mechanism of the invention meets this requirement, regardless the ergonomic group. The underlying mechanism of the device allowing the passive motion movement is related to two "points of control". The "points of movement control", herein also referred to as the "points of control", are located on the lower arm section of the mechanical arm support and include a point of control of the wrist 1 and a point of control of the elbow 2. A patient can go through a series of arm movements.

A first type of movement includes adduction or abduction movement. "Abduction" and "adduction" is the movement of the arm away from and toward the median axis, or long axis, in the median plane of the body. The "median plane" of the body is defined by the front or back of the body in a straight position. "Abduction" is the movement away from the median axis, such as raising an arm laterally or sideways. "Adduction" is the opposite movement, i.e., movement toward the median axis of the body. Adduction and abduction are herein defined as the parallel movement of both points of control. According to the invention, the degrees of movement for adduction or abduction are comprised between a start angle of 10° up to 70° end angle.

A second type of movement includes the rotation of wrist and elbow. During the rotation of the wrist the point of control of the elbow is immobilised and the point of control of the wrist moves up and down versus the neutral horizontal plane. During the rotation of the elbow, the point of control of the wrist is immobilised and the point of control of the elbow moves up and down versus the neutral horizontal plane. The degrees of movement for the rotational movement are comprised between 30° up and 30° down with relation to the neutral horizontal plane. This corresponds to a linear displacement of 250 mm up to 300 mm. For instance, when the neutral position of the lower arm is at horizontal (0°), the lower arm can move 30° up and 30° down with relation to the neutral horizontal plane. Then, the elbow / shoulder axis acts as hinge.

A third type of movement includes a combined movement of both wrist and elbow by alternating movement of both points of control versus the neutral horizontal plane. The movement of the wrist and the movement of the elbow occur at the same time but in opposite

direction. For this combined movement, the virtual rotation point is situated in the middle of the lower arm. The maximum deflection can vary between 40° and 60°.

A fourth type of movement involves the movements of exo/endo rotation, i.e. the movement of antepulsion and retropulsion. The terms "external rotation" or "exo rotation" or "retropulsion" are used as synonyms herein and refer to rotation away from the median axis of the body. The terms "internal rotation" or "endo rotation" or "antepulsion" are used as synonyms herein and refer to rotation toward the median axis of the body. These movements take place in parallel with the neutral horizontal plane. The endo/exo rotation movement corresponds to a linear displacement of 250 mm up to 300 mm.

A patient can go through a series of arm movements, which can be adjusted in terms of the type of movement, the alternation of the movements and their speed. Importantly, according to the device of the invention, the shoulder joint has no mechanical hinge or other kind of support. The type of movements a patient should undergo can be programmed, due to the use of a programmable motor mechanism. Unexpectedly, single as well as combined movements can be performed when using the device according to the invention. Although all the above-described movements include very different motions, such as translational as well as rotational movements, they can all be performed using the motor mechanism of the device. Also, the degree of motion can be adjusted by the motor mechansism. In addition, no extreme movements are imposed upon the patient, which may cause more harm than good. Importantly, as they are motor-driven all movements can be performed in a controlled way and the patient can stop the automatic movement at any time.

In a preferred embodiment, the invention relates to a device wherein said brace comprises a lower arm support for supporting the lower arm of a user; an upper arm support for supporting the upper arm of a user; said upper arm support being attached to said lower arm support by a hinge, and a hinge for connecting said lower arm support with said upper arm support.

In another preferred embodiment, the invention relates to a device wherein said programmable motor comprises a secondary frame, connected to the primary sub frame of said lower arm support by means of a mechanical interface, said frame linking the point of movement control of the wrist with the point of movement control of the elbow; two motor units, wherein one motor unit is provide for the wrist point of and one unit is provided for

elbow point of movement control, said motor units being able to perform a vertical movement; and a mechanical interface, provided at the elbow and connected to the secondary sub frame and the primary sub frame of the lower arm support.

In yet another preferred embodiment, the invention relates to a device wherein said positioning means consists of an inflatable housing of flexible material provided with a hip fastening means, said housing allowing at least partly deformation when fastened on a body for providing a stable position.

Figures 2 and 3 represent a preferred embodiment of the device according to the invention. The device according to the invention immobilises the upper arm and the lower arm by means of an adjustable mechanical support system, comprising a lower arm support 3 and upper arm support 4 provided with a primary sub frame and arm fasteners 10. Two simple plastic structures support the upper and lower arm. A simple metal, preferably aluminium, sub frame supports the plastic support structures. This sub frame is referred to as "primary sub frame". The angle between lower arm and upper arm is controlled by the mechanical hinge 5 of the primary sub frame. This hinge is geometrically located under the patient's elbow. The mechanical hinge can be adjusted, continuously, and locked mechanically. By providing the mechanical hinge point under the elbow, physical contact with the elbow is avoided and thus also injuries that might occur due to physical contact with the elbow are avoided. In another preferred embodiment the lower arm support of the brace is provided with a primary sub frame 3 and two arm fasteners 10; and said upper arm support is provided with a primary sub frame 4 and an arm fastener 10.

Another embodiment of the invention consists of a portable device wherein said arm fasteners 10 of said lower arm support and said upper arm support comprise fixing straps 12. Preferably, the lower arm support is further provided with a hand support cushion 13, being provided at the end of said support. This hand support cushion 13 prevents stress-points of the patients' arm tissue. The arm fasteners 10 and hand support cushion 13 provide support for the wrist and the hand. The patient's hand will therefore not hang off, a process which may cause discomfort, injury, or loss of circulation. According to another embodiment the arm fasteners of the lower arm support and the upper arm support have simple, fixing straps 12.

In another preferred mbodiment the portable device according to the invention comprises a device wherein said lower arm support is adjustable in order to fit the length of th upper and the lower arm of a user. The target group for use of the device of the invention mainly consists of adult men and women of the 5% to 95% ergonomic groups. As a consequence it is necessary that the device of the invention is adjustable to every patient. Several features of the device enable the independent adjustment and personalisation of the brace. The arm members are fixed on the plastic support structures by means of simple straps on 12. The plastic support structures can be adjusted in position to fit the upper and lower arm. The position of the hand support versus the lower arm support can be adjusted lengthwise. Consequently, the device is comfortable from a patients' point of view and is easy to apply. Additionally, the arm and shoulder brace is adjustable for a patient's length, body and anatomy and is adjustable with respect to speed and range of motion. All these features allow the device of the invention to be independently adjustable for use with either shoulder. Also, as mentioned above, the positioning means of the device consists of an inflatable housing of flexible material provided with a hip fastening means, e.g. a belt, said housing allowing at least partly deformation when fastened on a body for providing a stable position. Optionally, in another embodiment, the portable device according to the invention may further comprise belts provided with fasteners. The weight of the arm and the overall mechanical system of the device itself is supported by the positioning means, e.g. an inflatable air chamber 7. The inflatable air chamber 7 is kept in place with relation to the patient's body by means of a hip belt and optional belts with simple fasteners, e.g. Velcro. The fact that the positioning means consists of a flexible material involves several advantages. The positioning means is deformable under the weight of the brace and motor mechanism thereto connected. Also, it can easily adapt to the anatomy of a patient carrying the device. Furthermore, it can take in a comfortable position along the torso of a patient carrying the device.

The motor mechanism of the device essentially comprises a secondary sub frame, two motor units and a mechanical interface. The "secondary sub frame" is defined as the frame that links the point of control of the wrist and the point of control of the elbow. This type of mechanism is responsible for the movement of the points of control resulting in the following types of movement: adduction/abduction, a rotation of the wrist only, a rotation of the elbow only and a complex movement of wrist and elbow. The drive mechanism that enables the movement of the points of control is located in the zone between the mechanical support of the arm, i.e. the primary sub frame with plastic support structures, and the air chamber, as

indicated on figure 2. In another embodiment, the secondary sub frame linking both points of control has a mechanical transition to the primary sub frame. The connection between the secondary sub frame and the primary sub frames is provided by the mechanical interface, which is e.g. a hinge-like structure along the vertical axis, located at the patient's elbow.

Two motor units are provided in the motor mechanism, whereby one motor unit is provided for the wrist point of movement control and the other unit is provided for elbow point of movement control. Both motor units induce movements in a vertical direction. In a preferred embodiment, the invention relates to a portable device, wherein the first and second motor unit consists of a triple spindle with electro motor with worm wheel transfer, being provided in a housing, allowing the motor units to induce a vertical movement.

In another preferred embodiment, the motor mechanism of the invention is at least partially provided in a protecting structure, for instance a bellows structure. The protecting structure not only protects the drive mechanism but also provides protection for the brace user from being harmed by the mechanism. In the interests of safety, it is an advantage for the CPM device to be designed so that a minimum of the drive mechanism is exposed. If the operating parts of the device are concealed, and in the present invention even partially provided in the air chamber element, it reduces the risk of a patient's being pinched by the machine, or bed clothes getting caught in the mechanism. The bellows structure is preferably constructed from lightweight plastic. As it will be understood, the portion of the motor mechanism not provided in this protecting structure is provided within the positioning means.

The motor mechanism further comprises a mechanical interface, which interconnects the secondary sub frame of the motor mechanism with the primary sub frame of the lower arm support. In a preferred embodiment, this mechanical interface is provided with a motor-driven sliding mechanism, said mechanism allowing the lower arm support to perform a sliding movement. Preferably, the mechanical interface is a hinge-like structure 14, which is located at the patient's elbow between the primary and the secondary sub frames. The motor-driven sliding mechanism combined with the hinge enables the exo/endo rotation movement of arm and shoulder.

The motor mechanism is further illustrated on figure 4. The motor-driven sliding mechanism is located in a housing 14, and connected, via a secondary sub frame 15, with the control point

of elbow. A bellows structure 6 may be provided to protect the motor mechanism and to improve safety of the brace user. One motor unit is provided which controls th wrist movement 8 and another motor unit 9 controls the elbow movement. In addition, a foam block 16 is provided at the height of the hip. This block provides additional mechanical protection for a user of the device according to the invention and also provides protection for th air chamber unit of the device. The foam block avoids stress points on a user, which may be caused by contact of the user with the device according to the invention. The mechanical concept of the endo/exo rotation sliding mechanism is shown on figure 5, which giv s a detailed view on the relation between the sliding movement of the lower arm 17 and the compensating rotation movement 18 during the exo/endo rotation. The sliding mechanism, i.e. conduction of the lower arm support 3 according to arrow 17, is combined with a rotation point at the height of the elbow point of movement control, according to arrow 18. In a further embodiment, the motor units of the drive mechanism of the device comprise a motor unit for the wrist point of control 8 and a motor unit for the elbow point of control 9.

In a preferred embodiment, the motor units for the wrist and elbow points of control consists of a triple spindle with electro motor, which are mounted in a plastic housing. The motor units have compact electro motors with worm wheel transfer. This concept enables controlled movements that are stoppable at any point. Therefore, the device of the invention allows movements of the limbs to be performed in a controllable and preferably in an automated way.

A part of the drive mechanism is located in the volume of the positioning means 7, e.g. an air chamber, as shown on figure 6. The result is a very compact device. Surprisingly, this volumic arrangement does not hinder the functionality, i.e. a supporting and damping function of the air chamber. The linear movements of the points of control, in case of alternating movements, i.e. combined movements, results in a marked angel deviation (rotation) of the motor mechanism. This will be compensated by a flexible suspension of the motor mechanism in the air chamber, without compromising the function of the air chamber.

In a preferred embodiment, the device according to the invention further comprises a remote control unit. This remote control unit 19 is compact, comprising control switches and a LCD screen and can be plugged in by means of an electric cable. The medical personnel determines the maximum range of abduction/adduction or rotation within which the injured

shoulder should be exercised. The limits of these movement degrees are inputted to the remote control unit. The control unit is designed to operate in a manual or automatic mode selection of the operating mode being controlled by the patient via switches on the control unit. In an automatic mode used for continuous passive motion the control unit continuously operates the motor unit to perform the desired movements of arm and shoulder between the preset limits. Thus, in the automatic mode the shoulder can safely and continuously undergo programmed passive movements. Furthermore, the device according to the invention is provided with two compact connectors 20, 21, provided at the upper side of the positioning means 7, whereby one connector is connected to the remote control unit 19 and the other connector is connected to an electric transformer 28 or batteries 27. Optional batteries can be plugged into the air chamber's electrical interface. These batteries provide a minimum of autonomy in case power voltage is not available. In the other case, a compact transformer is used. As a consequence, the arm and shoulder brace of the invention is designed in such a way to allow sufficient autonomy of the device.

Apart from the adjustability to the patient's individual anatomy, another important feature comprises the fact that the device is built in such a way in order to be easily adapted for use with the right shoulder as well as the left shoulder. The flexible immobilization of the left arm can be done in the same conditions and in symmetric way for the right arm. The following features enable this right and left arm use. The plastic supports supporting upper and lower arm and the underlying primary sub frames have a symmetric design. Also, the elbow hinge point turns in such a way that the device is adjustable for the left as well as the right arm. Furthermore, all other interfaces are built symmetrically or enable easy adjustment for l ft or right use.

As mentioned above, the device is light and portable. This feature enables the device to be transported from room to room in order to enable different patients to share the CPM device. Also, it is of even further advantage that the device is designed to allow the patient to wear the device since the patient may be subjected to continuous treatment. The patient may thus remain mobile while being subjected to CPM treatment. This facilitates treatment, which may last for several hours or longer per session. Another feature is that the arm and shoulder brace is useable in every day circumstances and it can already be used immediately after an operation even before the user has regained consciousness. As it is important that the device is portable, both from the standpoint that it is possible that it must be carried from room to

room in the hospital, and also that it is of an advantage to provide a device which allows a certain amount of mobility for the user, the device is designed to be as light as possible. Thus, where it is possible, the parts such as the lower and upper arm supports, the bellows structure concealing the drive mechanisms, are constructed of light weight material, preferably of a lightweight rigid plastic. In addition, also from ergonomic point of vi w, the device of the invention has several innovative characteristics. Importantly, the device avoids the presence of any support, i.e. stress points, on or next to the injured shoulder. The arm and shoulder brace has support structures, which do not cause any "pressure points". Amongst these structures are the hip, hand and arm supports, the hand cushion, the inflatable air chamber. Also, the hand support on the device is parallel with lower arm, which is important from ergonomic point of view, as it avoids an hanging off of the hand and injury of hand and wrist, which may result in a bad circulation and oedema. Furthermore, the device is provided with several belts, which are easy and unambiguous to use. Importantly, these belts do not cross the breasts, which may be sometlmes painful.

In another preferred embodiment, the invention relates to the use of the portable device according to the invention for medical application. In particular, the invention relates to the use of the portable device according to the invention for orthopedic treatment of arm and shoulder injuries. Use of the device can be envisioned as follows. The device is adjusted to a particular user. The device is then activated for continuous motion of the user's shoulder, causing both abduction and adduction and rotation. The proper periods of treatment are to be determined by the medical personnel. The machine may also be used while the user is asleep.

The many advantages and innovative characteristics of the arm and shoulder brace according to the invention render the device particularly suitable for use in paramedical and orthopedic applications.

While the invention has been shown and described with respect to a particular embodiment thereof, this is for the purpose of illustration rather than limitation, and other variations and modifications of the specific embodiment herein shown and described, all within the intended spirit and scope of the invention, will be apparent to those skilled in the art.

CLAIMS

1. A portable device suitable for providing continuous passive motion of a limb comprising:
   - a brace for supporting said limb;
   - a programmable motor providing continuous passive motion of said limb, said motor being mechanically connected to said brace; and
   - flexible positioning means provided with a fastening means positioning said brace and said programmable motor on the body of a person carrying said device in a stable position;

   characterized in that said programmable motor is at least partially housed within said positioning means.

2. A portable device according to claim 1, wherein said brace comprises
   - a lower arm support for supporting the lower arm of a user;
   - an upper arm support for supporting the upper arm of a user; said upper arm support being attached to said lower arm support by a hinge, and
   - a hinge for connecting said lower arm support with said upper arm support.

3. A portable device according to claim 1 or 2, wherein said programmable motor comprises
   - a secondary frame, connected to the primary sub frame of said lower arm support by means of a mechanical interface, said frame linking the point of movement control of the wrist with the point of movement control of the elbow;
   - two motor units, wherein one motor unit is provide for the wrist point of and one unit is provided for elbow point of movement control, said motor units being able to induce a vertical movement; and
   - a mechanical interface, provided at the elbow and connected to the secondary sub frame and the primary sub frame of the lower arm support.

4. A portable device according to any of claims 1 to 3, wherein said positioning means consists of an inflatable housing of flexible material provided with a hip fastening means, said housing allowing at least partly deformation when fastened on a body for providing a stable position.

5. A portable device according to any of claims 1 to 4, wherein said lower arm support of said brace is provided with a primary sub frame and an arm fastener; and said upper arm support is provided with a primary sub frame and an arm fastener.

6. A portable device according to claim 5, wherein said arm fasteners of said lower arm support and said upper arm support comprise fixing straps.

7. A portable device according to any of claims 1 to 6, whereby said lower arm support is further provided with a hand fastener and a hand support cushion, being provided at the end of said support.

8. A portable device according to any of claims 1 to 7, wherein said lower arm support is adjustable in order to fit the length of the upper and the lower arm of a user.

9. A portable device according to any of claims 1 to 8, wherein the first and second motor unit consists of a triple spindle with electro motor with worm wheel transfer, being provided in a housing, allowing the motor units to induce a vertical movement.

10. A portable device according to any of claims 1 to 9, whereby the mechanical interface is provided with a motor-driven sliding mechanism, said mechanism allowing the lower arm support to perform a sliding movement.

11. A portable device according to any of claims 1 to 10, wherein the positioning means further comprises belts provided with fasteners, for positioning said device on a body.

12. A portable device according to any of claims 1 to 11, further comprising a remote control unit, for controlling the passive movements provided by the device.

13. A portable device according to claim 12, wherein said remote control unit comprises control switches and a LCD screen.

14. A portable device according to any of claims 1 to 13, further comprising two connectors, provided at the upper side of the positioning means, whereby one connector is connected to

the remote control unit and the other connector is connected to an electric transformer or batteries.

15. A portable device according to any of claims 1 to 14, wherein the passive arm movements provided by the device are provided in an automated way.

16. Use of the portable device according to any of claims 1 to 15 for medical application.

17. Use of the portable device according to claim 16 for orthopedic treatment of arm and shoulder injuries.

ORTHOPEDIC ARM AND SHOULDER BRACE

ABSTRACT

The present invention relates to a portable device for providing continuous passive motion of a limb comprising a brace for supporting said limb; a programmable motor providing continuous passive motion of said limb, said motor being mechanically connected to said brace; and flexible positioning means provided with a fastening means positioning said brace and said programmable motor on the body of a person carrying said device in a stable position, in particular characterized in that the programmable motor is at least partially housed within the positioning means. The invention is particularly suitable for use in paramedical and orthopedic applications.

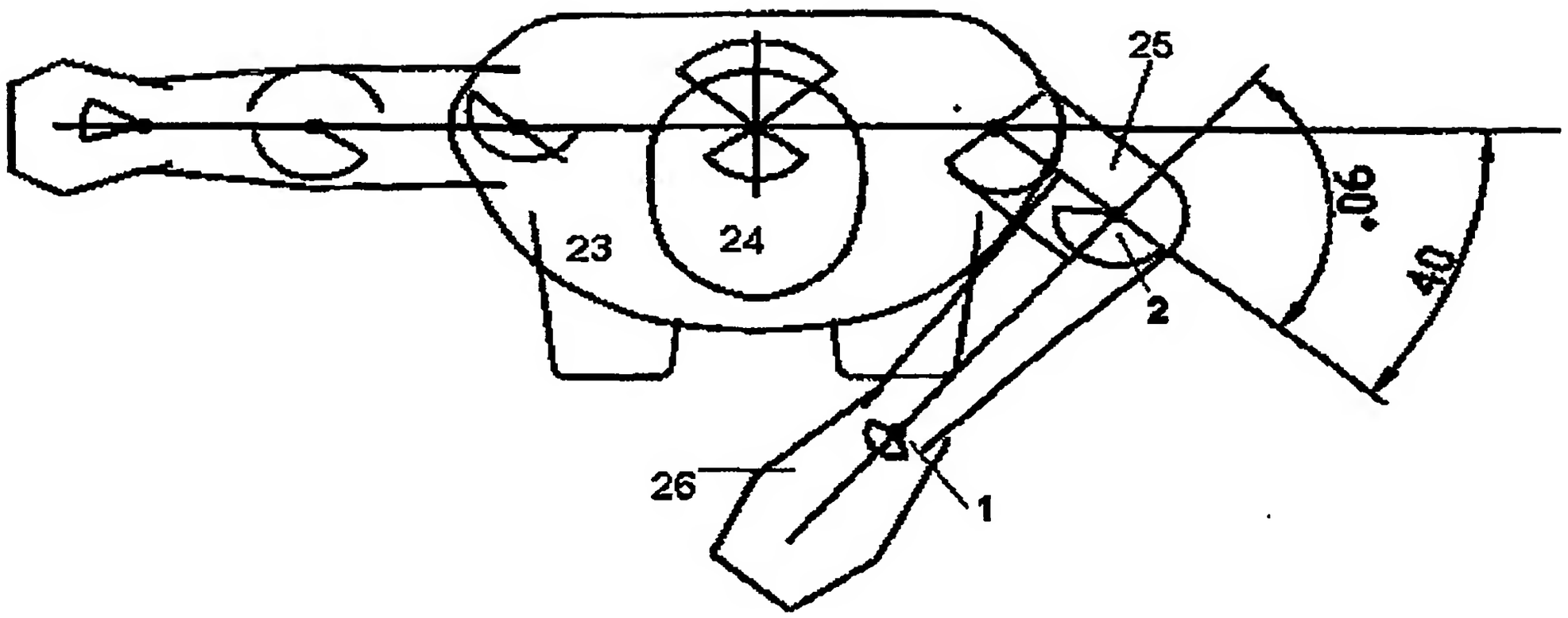

Figure 1

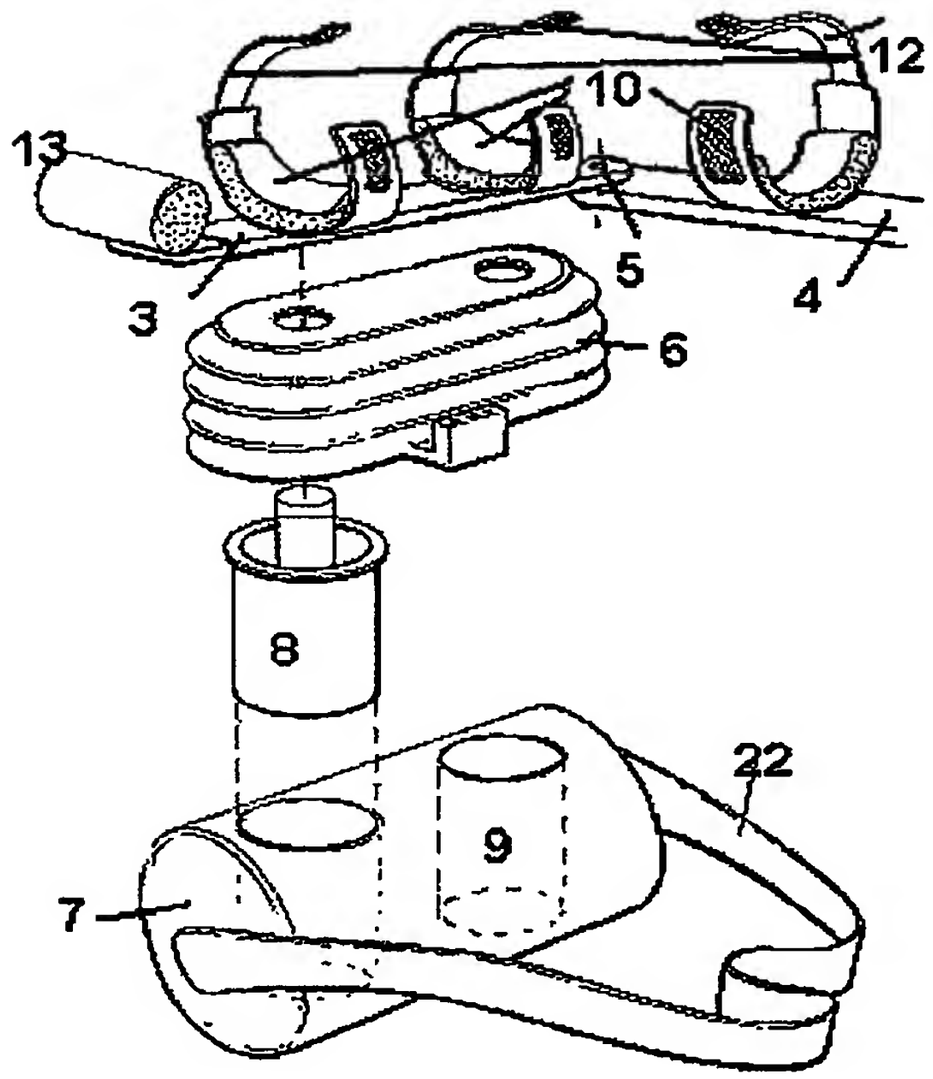

Figure 2

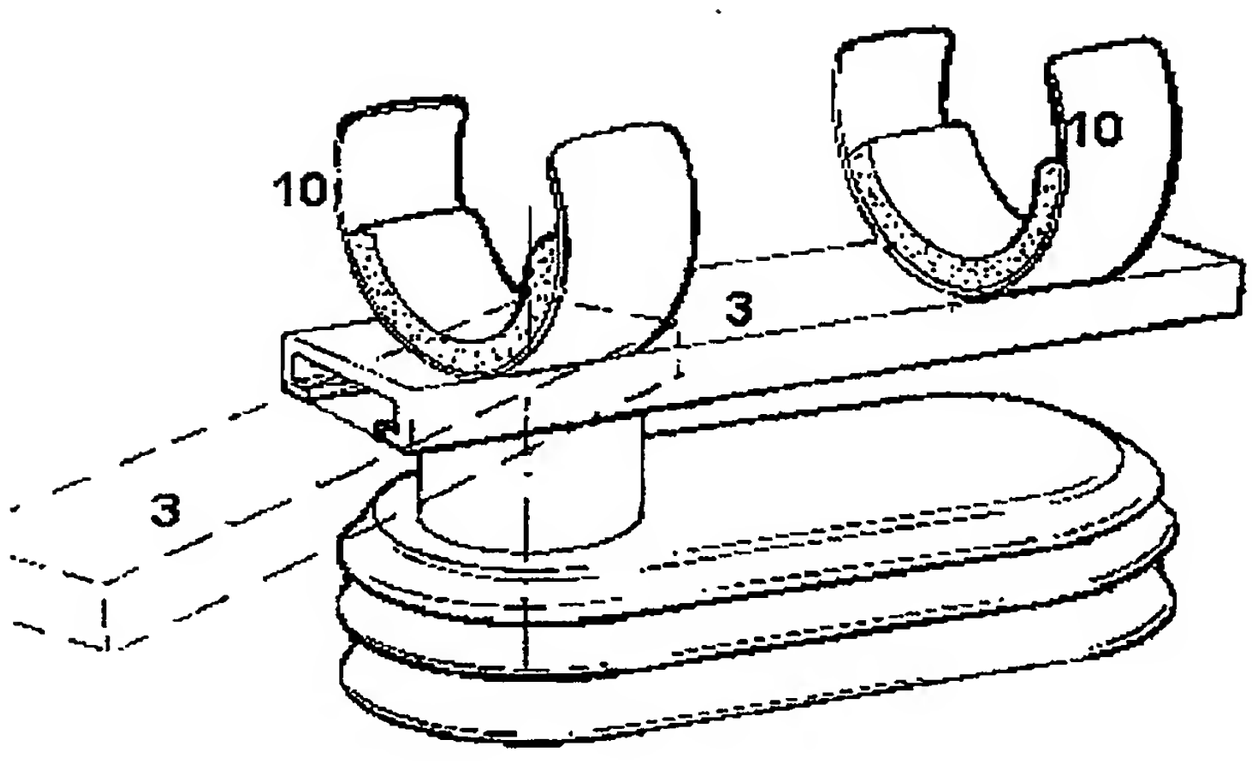

Figure 3

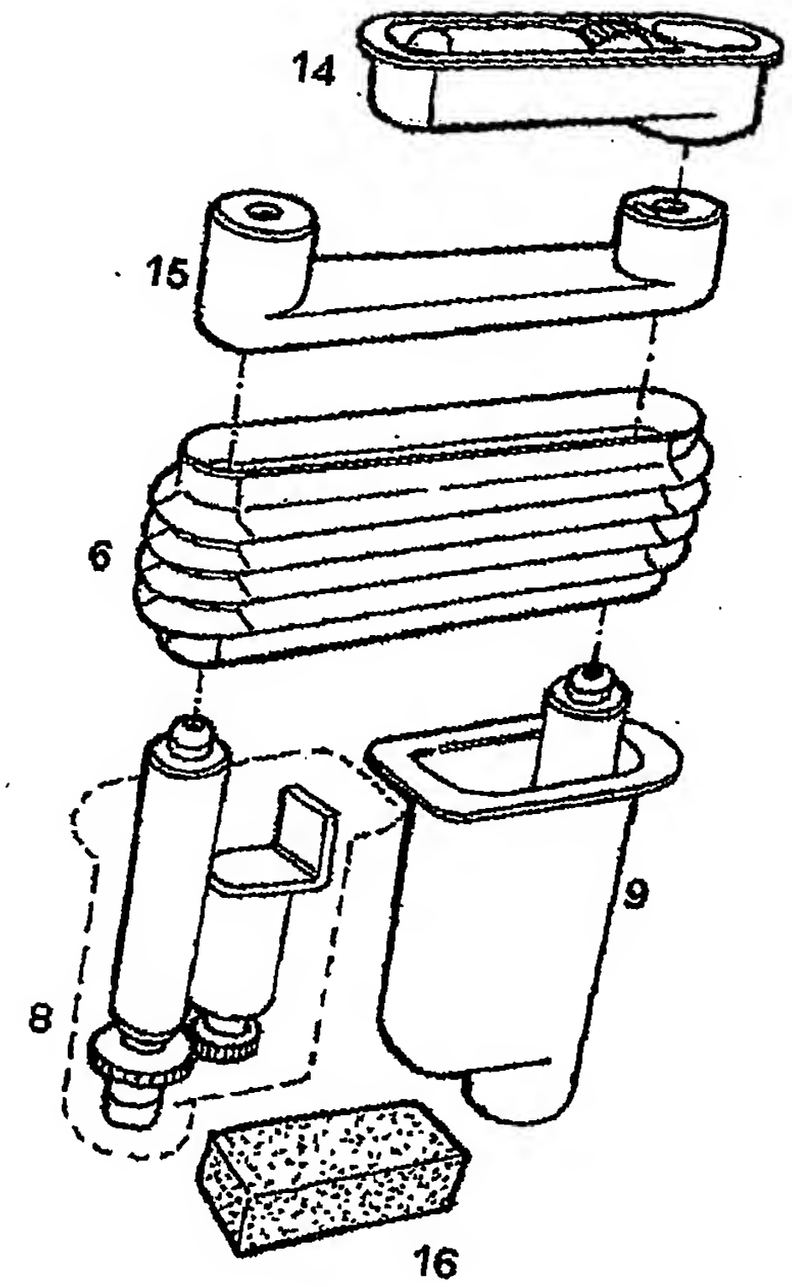

Figure 4

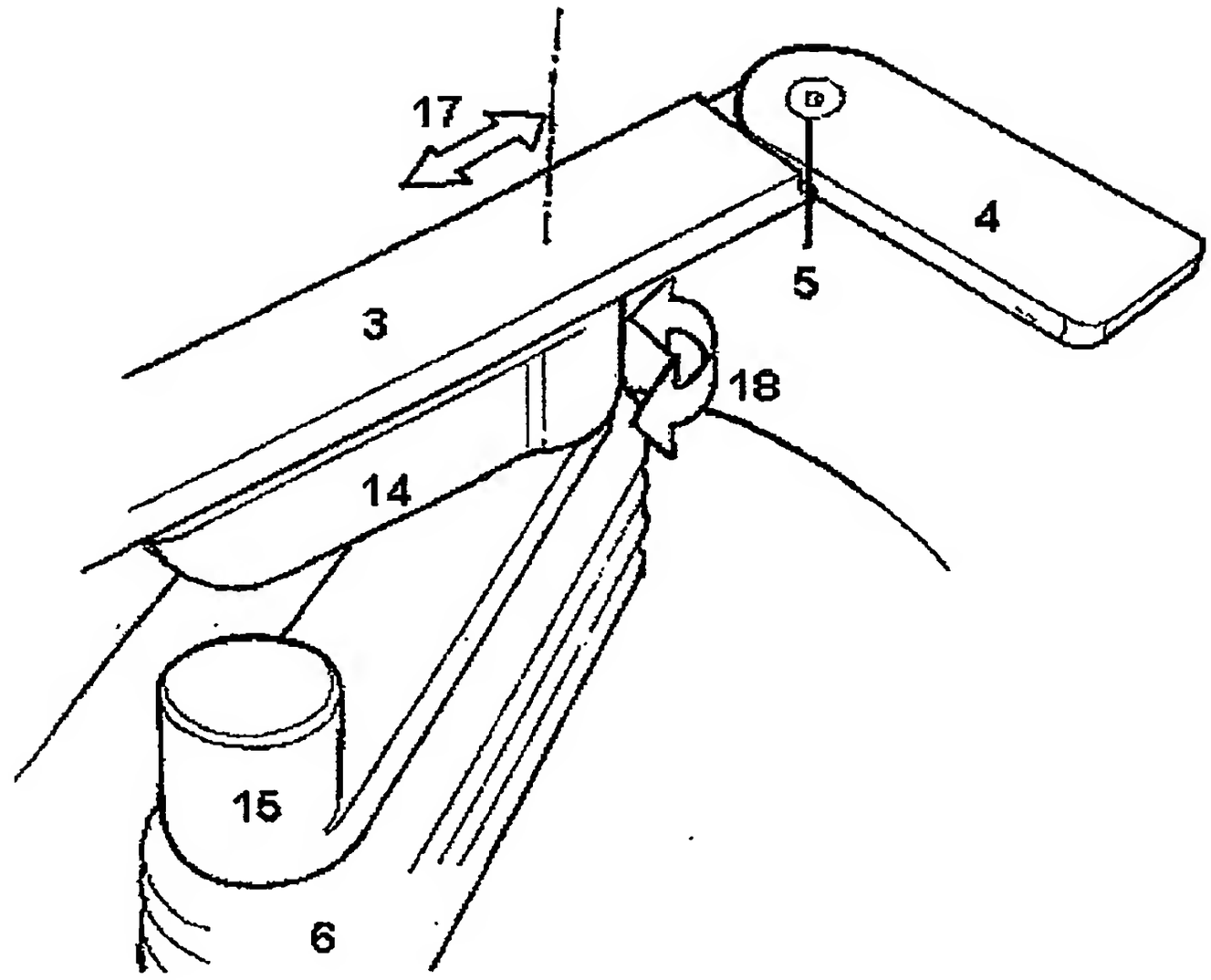

Figure 5

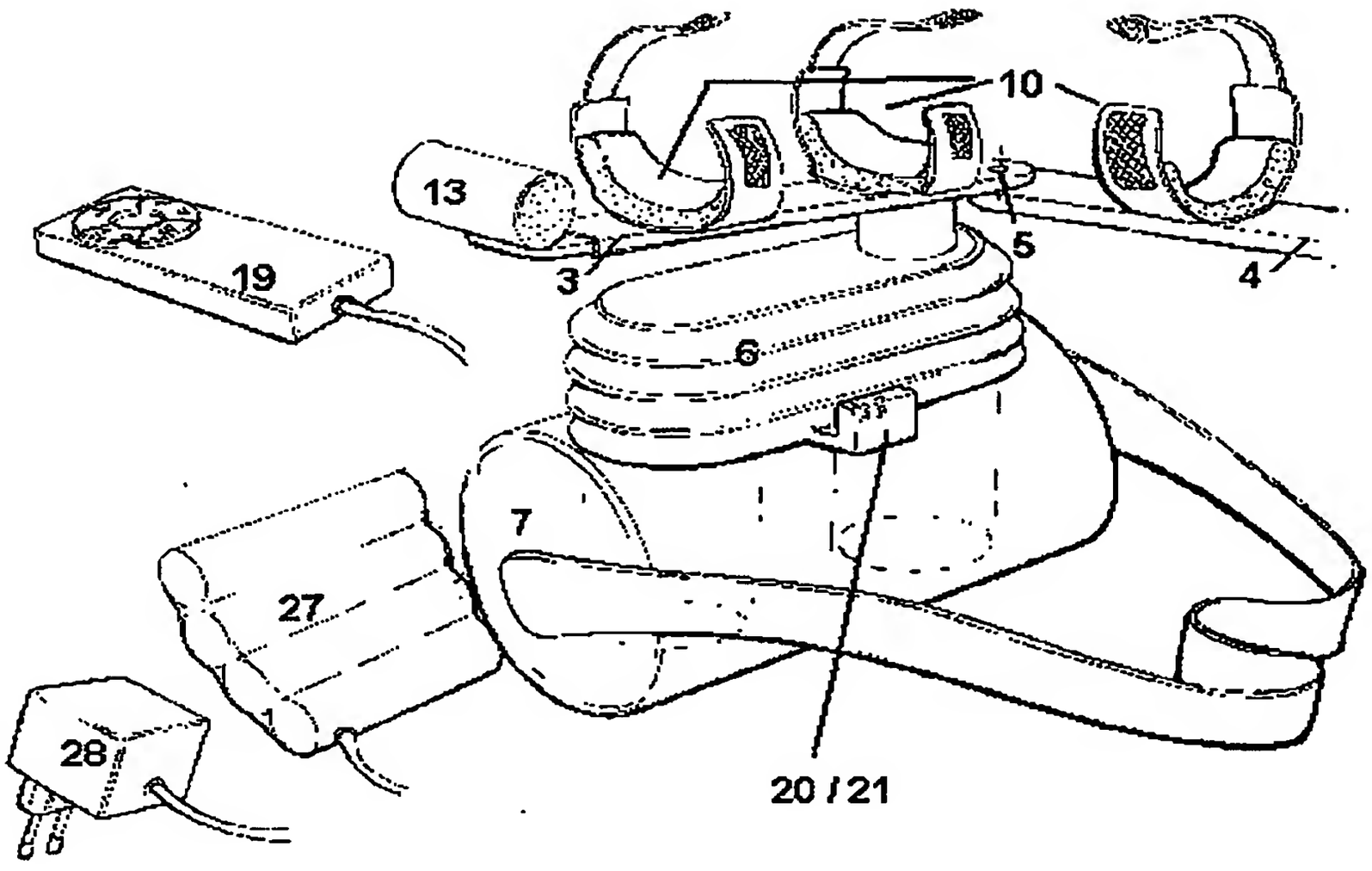

Figure 6